I. Project Title: Green and Yampa River Basin Sediment Monitoring Program

II. Principal Investigator:

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III. Project Summary:

The Recovery Program has identified a need to better define the requirements, appropriate methodologies, and levels of effort for a sediment monitoring program, to help define habitat requirements for endangered fishes in the Yampa, Little Snake, and Green rivers. To meet that need, an independent peer review panel was formed to review historical data, review the status of ongoing data collection efforts, identify sediment issues as they relate to recovery of endangered fishes, and develop recommendations for future sediment work to support Recovery Program efforts. Based upon peer review recommendations, an initiative to collect sediment data was started in 1998. During 1998, 25 suspended sediment and bedload samples were collected at the two Yampa River sites and one Green River site between May 6 and June 30, 1998. The data were published in Water Resources Data for Colorado, 1998 vol. 2 (Water-Data Report Co-98-2). During the second year of data collection (1999), 14 samples were collected at the two Yampa River sites and the Green River site between March 31 and June 24. In addition, 18 suspended and bedload samples were collected on the Green River above Canyon of Lodore during varied reservoir releases from Flaming Gorge under the scope of work for a separate project.

IV. Study Schedule: Initial year - 1998, Final year - 2008

V. Relationship to RIPRAP:

Yampa River Action Plan: Yampa and Little Snake Rivers1.A.4.a(3)
Yampa River Operation and Management Plan

VI. Accomplishments of FY 2000 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Bedload and suspended-sediment sampling were continued during Water Year (WY) 2000 on the Green River above Gates of Lodore, Yampa River above Little Snake River, Yampa River at Deerlodge Park, and Green River near Jensen, Utah, as part of the long-term data collection program established in 1998. After sampling the Green River above Gates of Lodore in water-year 1999 in response to a special Bureau of Reclamation request, the site was added to the network in Water Year 2000. Sediment samples also

were collected on the Little Snake River near Lilly; Colorado gage.
Water Year 2000 Activity:

An assessment of the existing sediment and discharge data was made for each sampling site early in the spring of 2000 to establish the discharge range most in need of additional sediment data. Many of the existing sediment measurements had been made at or near the peak discharge, and it was determined that WY 2000 samples would be made at low to intermediate discharges to better define sediment rating curves over the full range of transport conditions. Another objective was to determine if strong hysteresis effects existed in the data (e.g., do sediment concentrations on the rising hydrograph limb differ from those on the falling limb). Samples were collected from early April until early July and included both the rising and falling hydrograph limbs, with a greater number of samples from the rising limb. Snowmelt runoff this water year was atypical, with a streamflow peak in early May and another peak after extremely warm weather at the end of May. The effect of the early peak on the transport rating curve is, as yet, unknown.

Suspended and bedload sediment samples were sent to the USGS Sediment Lab in Iowa City in early August 2000. Results of the laboratory analyses have not yet been received. The requested laboratory procedures for the WY 2000 samples are consistent with procedures used to analyze samples from previous years. Full sediment size analysis (coarser than 0.062 mm) and sand/fine breaks (percent finer than 0.062 mm) will be performed on all 23 suspended sediment samples. Silt/clay analysis (size fractions finer than 0.062 mm) will be performed on all suspended sediment samples having enough fine sediment for the procedure (about 10 of 23 samples). Full sediment size analysis will be performed on all (23) Helley-Smith bedload samples.

Water Year 2000 Samples:

Station	WY 2000 Samples	Discharge (cfs) Range	Total Samples (all years)
Green above Lodore	4 rise, 1 fall	1,340–4,830	15 rise, 5 peak, 3 fall
Yampa above Little Snake	3 rise, 1 peak, 1 fall	537–7,950	4 rise, 4 peak, 7 fall
Little Snake near Lily	3	unavailable	unavailable
Yampa at Deerlodge	3 rise, 1 fall	419–7,780	56 (including 1982, 1983)
Green near Jensen	4 rise, 1 fall	1,910–16,200	11 rise, 8 peak, 11 fall

Preliminary Findings (not including WY 2000 data) are briefly summarized as follows:

Green River above Gates of Lodore

Controlled reservoir releases provided limited opportunity to sample a wide range of discharge in 1999 (4,550 to 10,200 ft^3/s), the first year of data collection. Consequently, regression relations using existing data (1999) are poor (Total Load $R^2 = 0.21$). Small sample size (n = 18) and erratic reservoir releases have prevented any hysteresis from being identified. Five sediment samples from 2000 will help define the rating curve for discharges from 1,340 to 4,830 ft^3/s. Recommend that 2001 sampling focus on the falling hydrograph limb.

Yampa River above Little Snake River

Rating curves have relatively high R^2 values (Total Load $R^2 = 0.84$, Suspended Load $R^2 = 0.92$), but because of the small sample size from 1998 and 1999 (n = 9), the relations are not statistically robust. Five samples from 2000 cover the full range of observed discharges with two in previously unsampled low flow conditions (783 ft^3/s, rising; 537 ft^3/s, falling). Hysteresis effect undetermined. Recommend 2001 sampling concentrate on the rising hydrograph limb.

Little Snake River near Lily

Rating curves have not been derived for the existing sediment data (1997 and 1998, n = 34, suspended sediment only). Three samples from 2000 included both suspended and bedload sediment. Recommend 2001 sampling include bedload and suspended load over a wide discharge range. Bedload measurements are very important in characterizing sediment transport in sand-bed rivers.

Yampa River at Deerlodge Park

Sediment rating curves derived from 33 measurements in 1982 and 1983 were used to calculate annual loads for Total Load, Suspended Load, Bedload, and load by several size fractions (Elliott, Kircher, and von Guerard, 1984). Data collection resumed at Deerlodge Park beginning in 1997. Eighteen observations from 1997 through 1999 have been included with the 1980s data in new regression analyses that produced mixed results. The Total Load regression was slightly poorer ($R^2 = 0.72$ v.s. 0.79), the Suspended Load regression was slightly better ($R^2 = 0.79$ v.s. 0.76), and the Bedload regression was much poorer ($R^2 = 0.36$ v.s. 0.54) with data from the 1990s. The cause of this trend has not yet been identified, but is being investigated and could include changes in sampling location, sampling procedure, or in transport conditions in the river. In 1984, mild hysteresis effects were suggested by an interpretation of the data, but stronger statistical relations were derived from the entire data set rather than a data set subdivided on the basis of hydrograph period. Hysteresis effects in the 1990s and 2000 data have not been evaluated. Recommendations for 2001 might include continued data collection if it is

suspected that a change in the sediment transport conditions have occurred since the

1980s. If so, then sampling should be split between rising and falling periods, but also should include any "peak" discharge greater than about 13,000 ft^3/s, should it occur.

VII. Recommendations:

The data from WY 2000 will be evaluated along with data from earlier years for the five stations in the study. Rating curves will be derived for total load, suspended load, bedload, sand load, and sand load by size fraction, where the data are available. These rating curves will then be assessed for statistical strength and appropriateness for use in further transport evaluations or sediment budget estimates. Where rating curves have a low R-squared (R^2) value, an assessment will be made to determine the source of the poor statistical relation between load and discharge, and a recommendation for further action will be made. For example, a data set may have a low R^2 because samples were gathered from a limited discharge range (e.g., only near the peak); improvement could be made by future sampling at other discharges.

A similar analysis will be made of load and discharge data with respect to seasonal hysteresis. Rating curves will be derived for the rising and falling hydrograph limbs and, as before, these rating curves will then be assessed for statistical strength and appropriateness.

Data collection is planned to continue in WY 2001. Sampling frequency and timing are to be determined based partly on the awaited sediment laboratory analysis of the WY 2000 samples.

VIII. Project Status: Ongoing and on-track; the current study runs from 1998 to 2001.

IX. FY 2000 Budget Status:

A. Funds Provided:	$66,000
B. Funds Expended:	$66,000*
C. Difference:	$ 0

*$ 8,900 was used to jump start the Highline Lake Water Quality Study. The funds will be restored in the 2001 budget cycle.

The USGS has provided $25,000 of match for this project to do additional analysis and correlation with data collected earlier in the century.

X. Status of Data Submission:

Sediment data are available for 1998 and 1999, samples collected in 2000 have been submitted to a USGS lab for analysis. A review draft report will be available by mid summer 2001 and a final USGS Water-Resource investigation should be completed by December 2001.

XI. Signed: *George Smith*, for John Elliot — December 28, 2000
Principal Investigator — Date